Mergers

Paul T. Scott

Toulouse School of Economics

ptscott@gmail.com

Empirical IO

Spring 2014

Outline

Introduction to merger policy and analysis

Jaffe and Weyl (2013)

Miller et al (2013)

Benkard et al. (2010)

Merger policy enforcement

- In many cases, no firms would have an incentive to challenge a merger – a merger might raise the prices and profits of competitors not involved in the merger.
- Competition authorities generally play an active role in assessing mergers – DOJ and FTC automatically review mergers involving a firm with over $100mil in sales; EC automatically reviews those with joint sales over €250mil.
- Stated goal of antitrust authorities is typically protecting consumer welfare. Note that this is not obviously the right criterion (why not total economic surplus?)

Scope of merger analysis

- The joint DOJ-FTC merger guidelines lay out criteria used to assess mergers. Other antitrust authorities have similar publications.
- Older versions of the guidelines used notoriously crude screens. The screens have certainly evolved over time, but the jury is still out on the effectiveness of newer screens.
- DOJ-FTC guidelines allow for the consideration of
  - "unilateral effects" (basically, how the merger changes in the Nash equilibrium), and
  - "coordinated effects" ("increasing the risk of coordinated, accommodating, or interdependent behavior among rivals")
  - We will focus on assessment of the former

Standard measures of concentration

- Four-firm concentration ratio (C4) is the sum of market shares of four largest firms. Cn for can be defined similarly for arbitrary n.
- Herfindahl-Hirschman Index is sum of squares of market shares of all firms. Typically the scale used by antitrust authorities is 0-10000:

$$HHI \equiv 10000 \cdot \sum_i s_i^2 = \sum_i (100 s_i)^2$$

- A major problem with measures of concentration is that they depend on market definitions (which set of firms is the relevant one?), which are rarely obvious in practice.

Graph 4: Change of HHI versus average price increase of merging firms

From Foncel, Ivaldi, and Khimich (2013) "Assessing the accuracy of merger guidelines' screening tools"

Computing the HHI

- Foncel et al. (2013) calculate ΔHHI using pre-merger shares. For example, suppose firms 1 and 2 are merging

$$\Delta HHI/10000 = \left((s_1 + s_2)^2 + \sum_{i \geq 3} s_i^2 \right) - \sum_i s_i^2$$

  where all the s's are measured using pre-merger data. This is what the antitrust authorities do, too.

- Perhaps using post-merger shares for the post-merger HHI would give us a more useful predictor (although perhaps still not a great one).

- However, what we need to predict post-merger shares is a full economic model, and if we have this, we might as well use the model to evaluate the merger (more on this possibility later).

HHI in Merger Guidelines

- Merger guildelines used to use HHI quite explicitly. E.g., the 1984 DOJ Merger Guidelines:

  "Post-Merger HHI Between 1000 and 1800. Because this region extends from the point at which the competitive concerns associated with concentration are raised to the point at which they become quite serious, generalization is particularly difficult. The Department, however, is unlikely to challenge a merger in this region producing an increase in the HHI of less than 100 points. The Department is likely to challenge mergers that produce an increase in the HHI of more than 100 points, unless the Department concludes, on the basis of the post-merger HHI, the increase in the HHI, and the presence or absence of the factors discussed in Sections 3.2, 3.3, 3.4, and 3.5, that the merger is not likely substantially to lessen competition.

- New 2010 guidelines *still* involve similar language, but reportedly the antitrust authorities rely less on HHI now.

Upward Pricing Pressure

- Recently, Upward Pricing Pressure (UPP) has been adopted by antitrust authorities for screening mergers.
- Intuitively, UPP is a measure of how changes in competitive incentives (which tend to increase prices) and cost efficiencies (which tend to decrease prices) balance out.
- Formally, UPP for the first of two firms is defined as:

$$UPP_1 \equiv D_{12}\left(P_2 - MC_2\right) - \Delta MC_1$$

where D_{12} is the diversion ratio:

$$D_{12} \equiv -\frac{\partial Q_2^D / \partial P_1}{\partial Q_1^D / \partial P_1}.$$

- Different versions of UPP exist. See Foncel et al (2013) for an overview.

Why UPP?

- UPP is defined without reference to what the relevant market is.
- Suppose firms 1 and 2 are single-product firms seek to merge, and consider the first-order condition for firm 1:

$$\text{Pre FOC(1):} \qquad P_1 = MC_1 + \frac{1}{Q_1^D\left(\partial Q_1^D/\partial P_1\right)}$$

$$\text{Post FOC(1):} \qquad P_1' = MC_1' + \frac{1}{Q_1^D\left(\partial Q_1^D/\partial P_1\right)} + \left(P_2' - MC_2'\right)\frac{\partial Q_2^D/\partial P_1}{\partial Q_1^D/\partial P_1}.$$

Ignoring changes in quantities and point elasticities, the difference between the two is UPP. Thus, UPP can be seen as a back-of-the-envelope price change prediction.

Why not UPP?

- Ignores responses of firms not involved in merger
- In priciple, requires demand estimation, which is typically difficult (antitrust authorities are reluctant to rely on it) and cannot typically be done correctly without revisiting the question of what the relevant market is.
- Not always the same sign as price changes, and bias can go in either direction (in general)
- Even weaker relationship with magnitude of price changes

Simulation approach

- One can formulate and estimate a game theoretic model of the industry and then simulate the market with and without the merger.
  - Simulation-based approaches have seem natural from a "new IO" point of view, but they are not regarded as sufficiently robust to be central to the analysis of antitrust regulators.
- For example, a simulation based approach might proceed as follows:
  - Estimate BLP model of demand for differentiated products.
  - Assume Nash-Bertrand price competition.
  - Calculate equilibrium prices (and perhaps consumer surplus and profits) with and without the merger. The merger changes the set of first-order conditions that we use, and it may change the marginal costs.

The research frontier

- Another approach – the "first-order" approach of Jaffe and Weyl (2013) – uses price theory to derive approximate predictions about the effects of mergers. The approach can handle different forms of comptition (Bertrand, Cournot), but it is still based on static firm behavior.
- Merger guidelines primarily focus on changes in prices and costs, but mergers may also affect entry, exit, investment, R&D, and product positioning.
- Higher prices are bad for consumers in the short run, but they may (or may not) lead to greater investment, which may benefit consumers in the long run (e.g., product innovation or investment in network infrastructure).
- The difficulty of computing equilibria for dynamic oligopoly games is the big barrer to dynamic merge simulations, but Benkard et al. (2010) suggest an approach which makes it tractable (with an important simplifying assumption).

"The First-Order Approach to Merger Analysis"
Sonia Jaffe and Glen Weyl (2013)

Overview

- Extends UPP idea to incorporate price responses by non-merging firms
- Predicts price changes for each product; weighting these changes gives change in consumer surplus
- Compatible with Bertrand or Cournot competition

Basics

- i and j will represent firms which want to merge
- Firm i's profits:

$$\pi_i = \mathbf{P}_i^T \mathbf{Q}_i(\mathbf{P}) - \mathbf{C}_i(\mathbf{Q}_i(\mathbf{P}))$$

- Premerger first-order conditions:

$$0 = -\left(\frac{d\mathbf{Q}_i^{-1}}{d\mathbf{P}_i}\right)^T \mathbf{Q}_i - (\mathbf{P}_i - \mathbf{mc}_i) \equiv \mathbf{f}_i(\mathbf{P})$$

GePP

- Jaffe and Weyl introduced generalized pricing pressure. Like UPP, GePP aims to capture changes in firms' pricing incentives.
- Premerger FOCs: $\mathbf{f}\left(P^0\right) = 0$
  Postmerger FOCs: $\mathbf{h}\left(P^M\right) = 0$
- GePP defined as the change in the first-order conditions at premerger prices:

$$\mathbf{g}\left(P^0\right) \equiv \mathbf{h}\left(P^0\right) - \mathbf{f}\left(P^0\right)$$

Diversion ratio

- Define a diversion ratio matrix slightly differently than before:

$$\tilde{D}_{ij} \equiv -\left(\frac{d^M \mathbf{Q}_i^{-1}}{d\mathbf{P}_i}\right)^T \left(\frac{d^M \mathbf{Q}_j}{d\mathbf{P}_i}\right)^T$$

where

$$\frac{d^M \mathbf{Q}_k}{d\mathbf{P}_i} = \frac{\partial \mathbf{Q}_k}{\partial \mathbf{P}_i} + \frac{\partial \mathbf{Q}_k}{\partial \mathbf{P}_{-ij}} \frac{\partial \mathbf{P}_{-ij}}{\partial \mathbf{P}_i}$$

- The difference from the diversion ratio in the basic UPP definition is that this definition includes the equilibrium price responses of firms not involved in the merger. P_j is not assumed to respond as P_i changes because the merged firm would have control over both prices.

Proposition 1

- We can write GePP for one of the merging firms as follows:

$$\mathbf{g_i}\left(P^0\right) \equiv \tilde{D}_{ij}\left(\mathbf{P}_j - \mathbf{mc}_j\right) - \Delta\left(\frac{d\mathbf{Q}_i^{-1}}{d\mathbf{P}_i}\right)^T \mathbf{Q}_i - \Delta\mathbf{mc}_i$$

- Compare to UPP:

$$UPP_i \equiv D_{ij}\left(P_j - mc_j\right) - \Delta mc_i$$

- One difference is the diversion ratio in GePP considers reactions by non-merging firms. Another is the second term in GePP, which is implicitly assumed to be zero in the UPP formula (i.e., UPP ignores how changes in the quantity and point elasticity affect incentives).

Price changes

- Next, Jaffe and Weyl show how to map to price changes. This involves a measure of pass-through as well as GePP.
- **Theorem 1**: as long as $\mathbf{h} = \mathbf{f} + \mathbf{g}$ is invertible,

$$\Delta \mathbf{P} \approx -\left(\frac{\partial \mathbf{h}}{\partial \mathbf{P}}\left(\mathbf{P}_0\right)\right)^{-1} \cdot \mathbf{g}\left(P^0\right)$$

  where $-\left(\frac{\partial \mathbf{h}}{\partial \mathbf{P}}\left(\mathbf{P}_0\right)\right)^{-1}$ is the merger pass-through matrix.
- Their examples show that GePP on its own may be misleading. For a simple Cournot case, GePP shrinks to zero for undifferentiated products. However, there is still a price increase in the limit (homogeneous products) because the pass-through matrix blows up.

Estimation and implementation

- Note that while GePP depends only on first derivatives of demand, the pass-through matrix is based on the derivatives of the FOC's, and therefore it involves second derivatives of demand.
- One issue is that the first-order approximation involves an abstract "merger pass-through" matrix, which is based on $\frac{\partial \mathbf{h}}{\partial \mathbf{P}}$, the derivatives of post-merger FOC's.
- However, the pre-merger cost pass-through matrix corresponds to an observable object:

$$-\left(\frac{\partial \mathbf{f}}{\partial \mathbf{P}}\right)^{-1} = \frac{d\mathbf{P}}{d\mathbf{mc}},$$

and Jaffe and Weyl suggest that $-\left(\frac{\partial \mathbf{h}}{\partial \mathbf{P}}\right)^{-1} \approx -\left(\frac{\partial \mathbf{f}}{\partial \mathbf{P}}\right)^{-1}$, suggesting that an approximation to the matrix of interest can be estimated using pre-merger cost pass-through rates.

Consumer surplus

- Finally, the change in consumer surplus can be approximated to a first order by weighting price changes by quantities:

$$\Delta CS \approx -\Delta \mathbf{P}^T \mathbf{Q}$$

- In the end, to compute the first order approximation to price and surplus changes, we need to estimate:
  - Own- and cross-price demand elasticities (but not a full demand system) locally for the pre-merger equilibrium
  - The cost pass-through matrix for the pre-merger equilibrium.
- . . . these are relatively straightforward objects that don't require many structural assumptions to estimate

Comments

- It should be kept in mind that the first-order approximation is only reliable to the extent that the merger leads to *small* price changes. However, mergers are always a discrete change and may be a large one.
- Formally, the first-order approximation to price changes requires a measure of merger cost pass-through rates. This requires either identifying second derivatives of demand or approximating with pre-merger pass-through. Miller et al. (2013) suggest that the latter performs well.
- The approach is based on a static notion of competition.

"On the First Order Approximation of Counterfactual Price Effects in Oligopoly Market"
Miller, Remer, Ryan, and Sheu (2013)

Overview

- A paper by several DOJ economists putting the first-order approach to the test
- Main findings:
  - simulation-based approaches go very wrong when using the wrong demand specification (and there's little reason we can hope to get it right in practice
  - First-order approach seems to be more robust

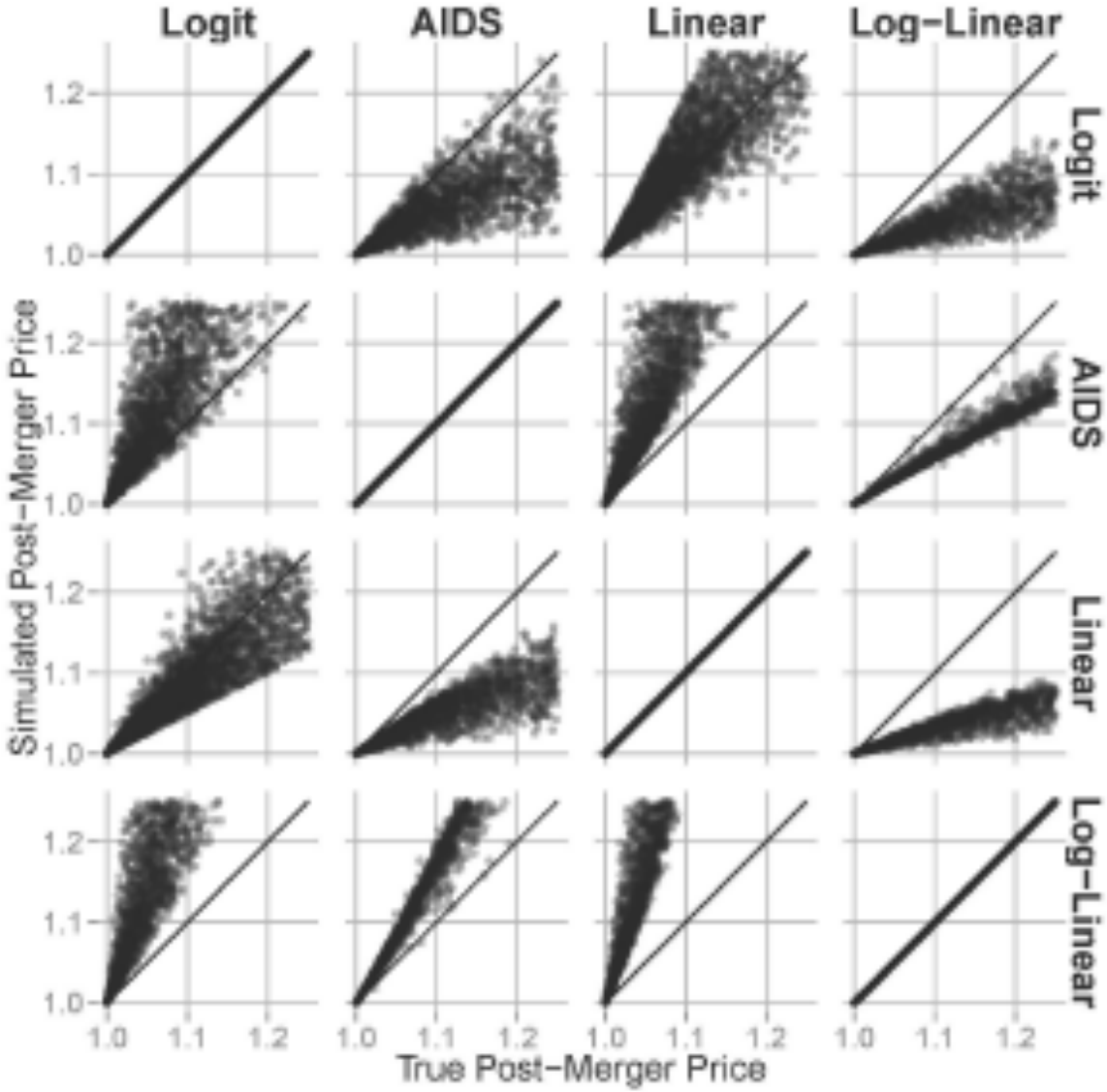
Simulations

- They simulate 3000 data sets using logit, almost ideal, linear, and log-linear demand systems.
- For each simulated data set, they perform merger evaluations using:
  - the first-order approach
  - a simulation with the correct demand specification
  - a simulation with each of the other demand specifications
- The sizes of the price changes resulting from the merger are calibrated to be in the 5-10% range, which is the range of difficult cases considered by antitrust authorities.

FOA implementation

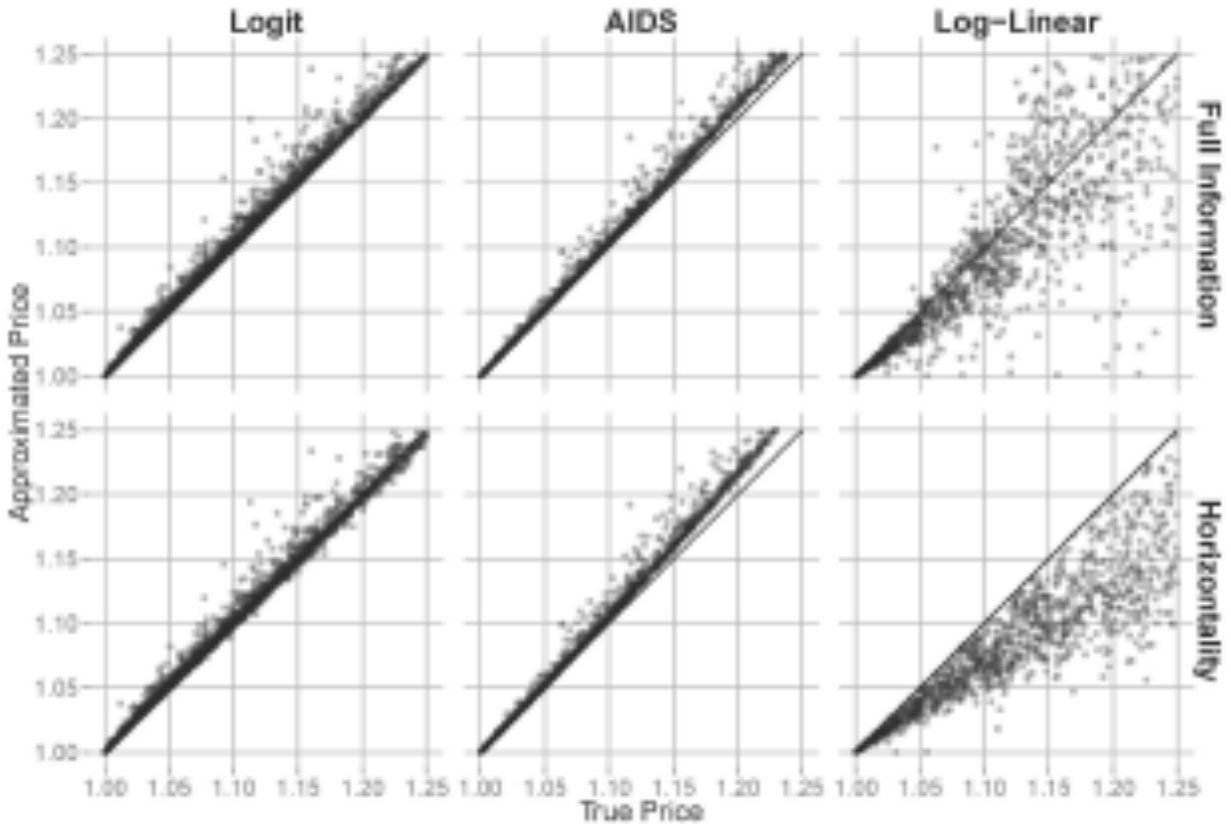
- Their first implementation of the first-order approach constructs the pass-through matrix correctly based on the second-order characteristics of the true demand system. This gives the first-order approach an unfair advantage because it is not so easy in practice to make reliable inferences about second derivatives.
- A second ("simplified") version of the first-order approach is the one described above, where pre-merger pass-through is used for the merger pass-through matrix. This seems like a more fair comparison.

Miller et al (2013)



Simulation-based price predictions

Miller et al (2013)



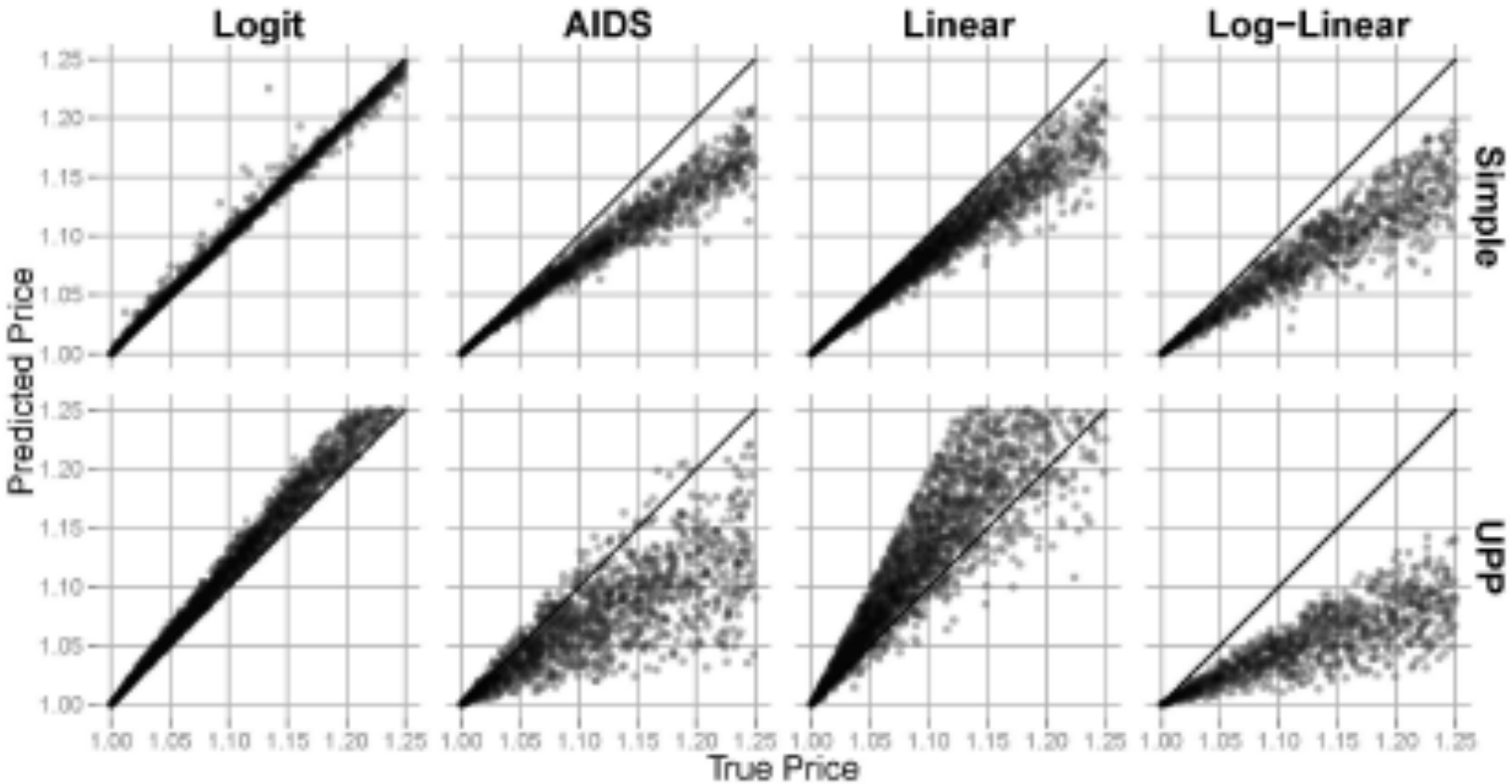
First-order approach price predictions

Table 4: First Order Approximation versus Merger Simulation

Panel A: Frequency with which FOA is More Accurate

	Underlying Demand System:			
	Logit	AIDS	Linear	Log-Linear
Logit Simulation	.	95.1%	100%	76.2%
AIDS Simulation	99.8%	.	100%	64.7%
Linear Simulation	85.3%	96.5%	.	77.7%
Log-Linear Simulation	100%	99.3%	100%	.

Miller et al (2013)



Simplified first-order approach price predictions

Miller et al (2013)

Table 8: Simplified Approaches versus Simulation for Mergers

Panel A: Frequency Simple Approx. is More Accurate

	Underlying Demand System:			
	Logit	AIDS	Linear	Log-Linear
Logit Simulation	.	94.4%	52.7%	100%
AIDS Simulation	99.5%	.	99.8%	43.5%
Linear Simulation	91.3%	97.3%	.	99.2%
Log-Linear Simulation	100%	97.5%	100%	.

"Simulating the Dynamic Effects of Horizontal Mergers: U.S. Airlines"
Benkard, Bodoh-Creed, and Lazarev (2010)

Overview

- A unique attempt to evaluate the impacts of mergers with a dynamic equilibrium model
- The dynamics here are entry and exit, both in terms of airlines entering the industry and active airlines entering particular markets
- Estimation based on Bajari, Benkard, and Levin (2007)
- To avoid calculation of counterfactual (post-merger) equilibrium, rely on assumption that equilibrium does not change

Vague description of game

- A market is a city-pair, and the airlines active in that market are those with non-stop or one-stop service between those cities.
- Game involves entry, exit decisions for each market, and price setting for all markets the firm is active in.
- In principle, state space of game is gigantic – it describes whether each firm is active in each market. Note that if there are N destinations, then there are $N(N-1)/2$ markets.
- A first simplifying assumption is to consider different markets separately, which allows them to have cross-sectional variation and deal with a smaller state space.
- Another simplification is that there are two types of airlines: hub carriers and point-to-point carriers.

BBL estimation

1. Estimate policy functions (probabilities of entry and exit and probability distributions on prices) conditional on state variables
2. The second step of BBL is typically recovering profit function parameters using forward simulation based on the estimated policy functions, and using the Hotz-Miller inversion to map to differences in conditional value functions.
   - They omit this step because they're just interested in behavioral counterfactuals

Assumption1

- **Assumption 1:** The same Markov perfect equilibrium profile is played for all t whether or not the merger of interest takes place.
- They defend this assumption on the grounds that if the merger decision does not signal a shift in policy, it should not affect the equilibrium – it will only affect behavior by changing the state variables at the time of the merger.
- Given the assumption, they can simply forward simulate starting from initial conditions with and without the merger.
- What do you think?